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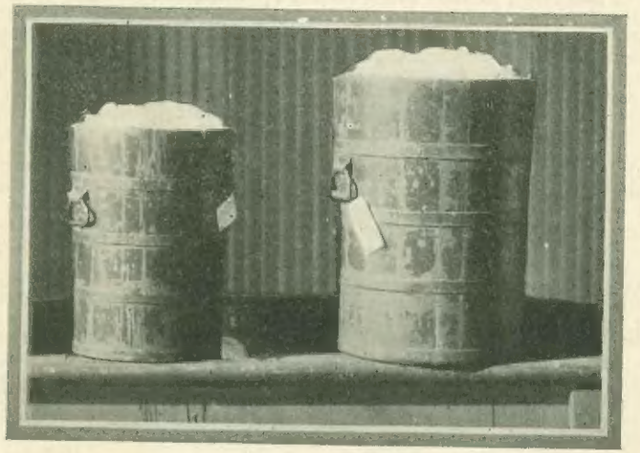
A. C. BAER



ICE CREAM—AN IMPORTANT WISCONSIN PRODUCT

Many creameries and milk plants can profitably engage in ice cream making as a side line. Only a small additional investment for machinery is needed.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON, WISCONSIN

DIGEST

The manufacture of ice cream is a growing Wisconsin industry. Creameries and milk plants can profitably make ice cream without much additional equipment. If advantageously located, they can install an equipment for the manufacture of ice cream for about $500. With a daily output of from 50 to 100 gallons, such an investment can be made profitable. Pages 3-5

The body and texture of ice cream are influenced by the age of the cream, the kind of cream frozen, the amount of butterfat or other milk solids in the "mix" and the kind and amounts of filler used. A freshly separated, freshly pasteurized or homogenized cream produces inferior ice cream. Aging the cream improves the quality. Additional milk solids and the various fillers commonly used improve the body and texture of ice cream and are necessary for the commercial manufacture of the product. Pages 5-9

The time of freezing and speed of the machine are as important as the proper ingredients. A mixture frozen too rapidly will be coarse and weak bodied. When the speed of the dasher or disks is too low, the ice cream is not whipped to the proper consistency and smoothness. Pages 9-10

An excessive overrun in ice cream is always obtained at the expense of quality. By careful standardizing of the ice cream "mix" and by regulating the freezing operation, it is possible to obtain a uniform overrun from day to day. A raw cream will produce a higher overrun than a pasteurized cream. Aging a pasteurized or homogenized cream makes a higher swell possible. Rapid freezing results in a lower overrun than when sufficient time is given to properly whip up the mixture. The kind and amount of filler does not seem to affect the overrun. A high swell results in an open textured, light, foamy ice cream and such a product is of poorer quality than one with less overrun. Because the amount of overrun affects the weight of ice cream, the nutrients in a given volume will also be affected, a high overrun ice cream contains less nutrients than a lower overrun product. Pages 11-18

The flavor of ice cream is influenced by the quality of the flavoring materials. A pure extract of vanilla will produce a more pleasant flavor than cheap, imitation compounds. The natural fruit flavors are more desirable than the cheaper grade of extracts. An old, tainted, partly sour cream cannot be made into a good ice cream. An excessive use of a low grade gelatine or ice cream powder, always can be detected in the flavor. Pages 19-22

A uniform quality of ice cream can be made throughout the season by careful standardization of the cream. A uniform butterfat content to comply with legal requirements makes it necessary to eliminate all guess work in making up the cream "mix." Pages 25-36

Ice Cream Making

A. C. BAER

The manufacture of ice cream can be made a profitable side line of a creamery or milk plant without the addition of much equipment. Ice cream is no longer manufactured only in factories in cities and by caterers and retailers who sell their own goods, but in recent years many creameries and even milk plants in the smaller towns and villages have been equipped for its manufacture. This is the result of a greater demand for the product, and the fact that it is not practicable or advisable to ship ice cream to very distant points.

The profits from the manufacture of ice cream are twice as great as from the making of butter. In Wisconsin, where a 14 per cent fat standard is required, a gallon of ice cream will contain approximately a pound of butter. This ice cream would sell at wholesale for at least seventy-five cents a gallon. The cost of producing a gallon of ice cream varies with such factors as the cost of equipment, the amount manufactured, and facilities at hand for icing and refrigerating. The cost in any case need not exceed forty cents a gallon, leaving a considerable margin of profit.

Despite the increasing demand and the consequent profit, ice cream making, except in the large wholesale manufacturing plants, is today where the manufacture of butter and cheese was twenty years ago. Much cream, especially that manufactured by creameries and small dealers, and in hotels, is made largely by guess, no attempt being made to standardize the operations. The product is not uniform from day to day and the differences in its quality are not well understood.

What is Ice Cream

The name "ice cream," as used in this country, covers a large number of frozen products made in so many different ways that any classification except a general one is more or less arbitrary. Two general classes of ice cream may be given, plain and fancy.

Plain ice cream is a frozen product made from cream and sugar, with or without a natural flavoring, usually containing a filler of some kind, and rarely, or never, eggs. Most of the common ice creams, such as vanilla, strawberry, and chocolate, belong to this class.

Fancy ice cream is a frozen product not coming under the first classification. Very often it contains eggs, as well as a variety of fruit flavors, nuts and colors, and is often moulded into various shapes and figures.

Ice creams have also been divided into ten classes.[1] These are: plain, nut, fruit, and bisque ice creams, parfaits, mousses, puddings, aufaits, lactos, and ices (which include sherbets, milk sherbets, frappes, punches, and souffles). No attempt has been made at the Wisconsin Station to work out a classification of ice creams or to establish definite formulas for their manufacture.

Very little is generally known in regard to the principles and practices involved in the manufacture of ice cream under commercial conditions. A large number of ice cream makers, especially those new or about to start in the business, do so largely on their own initiative with but little practical knowledge, gained, perhaps, from some employer. A large number of creamery operators or other men in position to make ice cream as a side line, will welcome a discussion of the various problems and principles involved in the commercial manufacture of the product.

It has been the aim to make this bulletin of service to manufacturers with either large or small plants and of special value to the beginner who wishes to avail himself of the increased profits of an ice cream business in connection with a creamery or milk plant.

WHAT EXPERIMENTS HAVE BEEN MADE

For the purpose of aiding the ice cream makers and those wishing to engage in the business who know very little or nothing about the subject, this Station has conducted a number of experiments.

These experiments represent about six hundred carefully planned freezings conducted, as nearly as possible, under

[1]Complete definitions of these various classes of ice creams and ices with suggestive formulas for their preparation, are given in Bulletin 123 of the Iowa Experiment Station.

commercial conditions. Most of the work was done with the plain ice creams, as a thorough understanding of the principles and problems involved in their manufacture will enable any ice cream maker, should occasion demand it, to take up the fancy trade.

In practically all of the experiments, freezings of from three to five gallons were used. These were made with either a five gallon upright "batch-ice" freezer or a continuous freezer using salt and ice brine. The ice cream was hardened and stored in a tank where ice and salt were used for refrigeration.

BODY AND TEXTURE DEFINED

Body, as applied to ice cream, refers to a general firmness of the finished product. Ice cream should be firm, yet not too hard; and mellow, but not slushy. To be of good body an ice cream should "stand up" well when placed in a dish and retain its firmness for some time.

Texture refers to the smoothness of the product. When the ice cream is taken into the mouth a smooth, velvety sensation is expected. A coarse, crystalline texture is disliked.

AGING ICE CREAM IMPROVES BODY AND TEXTURE

A freshly separated or freshly pasteurized cream will rarely produce ice cream of good body unless some filler is added. It is desirable that before freezing the cream should be aged from 24 to 48 hours. To keep it perfectly sweet, a low temperature must be maintained. This increases its viscosity and at the same time gives a firmness to the butter fat which results in giving the cream a better body.

Cream fresh from the pasteurizer or separator will generally produce an ice cream of coarse testure becoming more crystalline the longer it is kept. On the other hand, if the same cream is properly aged for at least 24 hours it will make a smoother ice cream which will retain its smoothness for a longer time. An ice cream may appear to have a fine body and smooth texture when it is taken from the freezer and still not be good from the standpoint of structure.

In every case where ice cream was made from fresh cream, it was found that the finished product, when hardened and stored, became mushy, with a weak body and a spiny, crys-

talline texture. On the other hand, when this same cream was properly aged for from 24 to 48 hours, both the body and the texture remained good much longer. While that made from fresh cream became coarse and spiny at the end of 24 hours, the ice cream from the aged cream was still in good condition after three days storage. All of these comparisons were made with an 18 per cent cream. With a thinner cream the contrast would likely be still greater. A richer cream (25 per cent fat) will produce an ice cream of fairly good body and texture even if frozen while fresh, but will make a much better product if aged before freezing.

RAW, PASTEURIZED, AND HOMOGENIZED CREAMS COMPARED

The body and texture of ice cream are affected to no small degree by the kind of cream that is frozen. A raw cream will invariably produce an ice cream of better body than pasteurized cream containing the same percentage of fat. The same cream when homogenized will serve better than when either raw or pasteurized. In the tests, the raw cream also produced a smoother article than the pasteurized cream, while that produced from the homogenized cream was the best of the three in texture.

In order to make these comparisons, three lots of 18 per cent cream were prepared, one being raw, one pasteurized, and the other homogenized; all three being of the same age when frozen. Six freezings of each of the three kinds of cream were made, the usual amount of sugar and vanilla being added but no filler. The freezing in each case was done as nearly alike as possible; the temperature of the mixture, the time of freezing, and the speed of the machine being the same in all cases.

All of the lots were hardened and stored for several days in a large wooden box well packed with salt and ice so as to keep them well hardened throughout the experiment.

The ice cream made from the homogenized cream had the best body and texture, showing no tendency to become coarse and icy at the end of three days storage. That made from the raw cream tested second, but began to show weakness and coarseness after the second day. When freshly made, the product from the pasteurized cream appeared to

have as good body and texture as that from the raw cream, but became coarse and somewhat icy after 24 hours storage.

By the judicious use of a filler, this defect in the raw or pasteurized cream can be overcome. When the cream is homogenized it may not be necessary to use a filler, as such an ice cream will have plenty of body and will not crystalize as rapidly in storage as that made from cream not so homogenized.

MILK SOLIDS DETERMINE QUALITY OF ICE CREAM

It is well understood in the ice cream business that the best body giving material is butter fat, and other milk solids. If made from a rich enough cream, the body and texture of the ice cream will be ideal. For the purpose of comparing the product made from cream of varying richness, mixtures from each of the following were frozen and studied: 8 per cent milk; 10 per cent, 15 per cent, 20 per cent, 22 per cent, 25 per cent, and 30 per cent cream. Six lots of each were frozen, hardened, and stored for several days in the same manner as before.

All lots made from cream testing less than 18 per cent fat were weak bodied and had a poor texture. After two days storage they were nothing more than "coarse, spiny stuff," not fit in any case to be called ice cream. The 18 per cent cream, when fresh, made fairly good ice cream and kept well for 24 hours. At the end of two days, however, the body became weak and the texture coarse.

The 20 and 22 per cent creams produced an ice cream of excellent body and texture, standing up well and showing no ice crystals after three days storage.

As would be expected, the 25 and 30 per cent creams made ice cream of ideal body and texture. The results of these experiments show that without the use of a filler it is difficult to make good ice cream unless a comparatively rich cream is used. Most commercial ice cream rarely has a higher fat content than 14 per cent, which means that it is made from approximately a 17 per cent cream.

FILLERS IMPROVE TEXTURE OF ICE CREAM

A filler, as known commercially, is some glutinous substance such as gelatine, gum tragacanth, or the various gelatinous products known as ice cream powders, which are

added to a mixture to impart better body to the ice cream and to prevent it from becoming coarse and icy in storage. The thinner the cream "mix," from which the ice cream is made, the more filler is needed to accomplish the desired results. Other substances occasionally used as fillers are eggs, corn starch and other starchy materials, such as rice or wheat flour. While rennet will accomplish practically the same results as a filler, it has not been used to any great extent.

Evaporated and condensed milks are used in the manufacture of ice cream to inpart better body to the cream and to enable the manufacturer to use less rich cream.

Whether or not an ice cream maker should use a filler depends upon the kind of product made and how soon it is to be consumed. There are numerous arguments for and against the use of a filler, but unless the ice cream is consumed within a day after it is made, a filler of some kind seems to be necessary to keep the product in good condition. As long as the manufacturers generally make ice cream from a comparatively thin cream, adhering closely to the legal limit[2], a filler is necessary for good results.

To demonstrate the value and need of fillers and the effectiveness of the various materials commonly used, some eighty freezings were made, half of the trials with a filler and along with these a control freezing without a filler from the same cream "mix." The fillers in three gallons of the mixture were: gelatine 2 ounces, gum tragacanth ½ ounce, evaporated milk ½ gallon, ice cream powder 2 ounces, and rennet 1 ounce. Twelve eggs to a five gallon mixture and small amounts of starches cooked to a paste, were also tested.

A control freezing from the same mixture without the filler was made each day and stored with the other. All were stored from four to seven days and the body and texture examined at intervals. The ice cream in all cases was made from 18 per cent cream, pasteurized and of the same age after pasteurization. In every case the product made without filler became coarse and full of crystals within 24 to 48 hours after freezing, while that made with the filler retained its smooth texture for five days or longer.

[2] In this state 14 per cent fat for plain ice cream and 12 per cent for the fruit and nut ice creams.

The gelatine, gum tragacanth and "ice cream powder" gave the best results, the product holding out longer than where the other fillers were used. The body of the ice cream was firmer in each case where a filler was used. The control sample without the filler was an inferior ice cream from the standpoint of body and texture.

Due to the additional milk solids, evaporated milk improved the body and texture of the ice cream considerably, but the texture did not hold out as well as when the other fillers were used. The condensed milk, however, imparted plenty of body to the finished product which retained its firmness during the entire period that it was stored.

The eggs and the starches as well as the other fillers, improved the ice cream in texture and body, but the effect was not as noticeable after three to five days of storage. Rennet produced as good results as the gelatine or the powder, the ice cream remaining in good condition for nearly two weeks without showing any tendency towards ice crystals or coarseness. On account of the difficulty of using the rennet as a filler, it will never occupy the place as such in the commercial manufacture of ice cream.

TOO RAPID FREEZING MAKES POOR QUALITY

The rapidity of freezing has a distinct effect on the body and texture of ice cream. A mixture frozen rapidly will always be coarse grained and weak bodied due to the freezing out of watery crystals before the mixture has been properly whipped into a smooth consistency. The proper freezing of a mixture is as essential as the proper ingredients. Usually the best results are obtained by freezing the "mix" in from 10 to 15 minutes. This does not freeze it too rapidly and at the same time allows plenty of time to whip the cream into the smooth consistency which is desirable in a good ice cream.

CORRECT SPEED OF FREEZER IS IMPORTANT

A proper speed of the freezer is necessary to obtain the desired smoothness and firmness in ice cream. A low speed of the dasher or disks will invariably result in a coarse, spiny, weak body.

All experiments tried with speeds of more than 100 revolutions a minute in the upright dasher freezer produced good results and the difference produced by three different speeds was hardly noticeable.

The speed of the revolving disks in the continuous freezer must be considerably greater than the speed of the dasher in a batch machine. The disks should be run at least 200 revolutions a minute for good results.

AN EXCESSIVE OVERRUN SHOULD BE AVOIDED

The swell or overrun is the volume of ice cream obtained over the volume of "mix" before freezing. It is an important item in commercial ice cream. While some swell is necessary in an ice cream of good quality, an excessive swell is always obtained at the expense of quality. Some manufacturers are satisfied with 50 or even a lower per cent, while others want a 100 per cent swell. Many ice cream makers still determine the overrun by measuring the volume of ice cream obtained from a certain volume of cream and do not take into consideration the sugar and other ingredients added.

The wrong and right way for determining the overrun may best be illustrated by an example. Suppose an ice cream maker has five gallons of 18 per cent cream and from this makes 10 gallons of ice cream after he has added sugar, vanilla, and filler. The five gallons of 18 per cent cream after the addition of the sugar, etc., amounts to 5.7 gallons of "mix." This made into 10 gallons of ice cream gives an increase in volume of 4.3 gallons or 75.4 per cent, instead of 100 per cent swell as is often supposed.

Too low a swell produces a heavy, soggy ice cream, while too high an overrun produces a light, foamy, open textured product. Every ice cream manufacturer should aim to get as high an overrun as is consistent with good quality. He should determine the quality of cream he wants to sell and regulate the overrun accordingly, keeping it from day to day as uniform as possible. Some of the factors that determine the amount of overrun are:

(1) Kind of cream: (raw, pasteurized, or homogenized;) (2) age of cream: (raw, pasteurized, or homogenized); (3) length of time of freezing; (4) speed of machine; (5) kind of machine; (6) amount of freezing; and (7) fillers used.

AGE AND KIND OF CREAM AFFECT OVERRUN

The amount of swell that can be obtained depends on the viscosity of the cream or its capacity to hold the air which is whipped into it by the freezer. A cream fresh from the separator, pasteurized, or even fresh from the homogenizer, appears very thin and has lost its original viscosity. A certain amount of aging, or holding the cream at a low temperature for 24 hours or longer, will greatly improve the viscosity of the cream and increase the overrun.

Because of its greater viscosity a larger amount of swell is possible from a fresh, raw cream than from a freshly pasteurized cream. For the same reason, a homogenized cream when frozen while fresh, may yield a slightly higher overrun than a pasteurized cream. In all cases, aging the cream helps in obtaining a greater swell.

Table I will illustrate the effect on the overrun of aging raw, pasteurized, and homogenized cream. The data is the result of experimental freezings using an 18 per cent cream with no filler. In each case, the temperature of the "mix" and time of freezing were as nearly alike as possible and the same amount of sugar was used.

TABLE I.—EFFECT OF AGING CREAM ON THE OVERRUN

Kind of cream	Age of cream	Per cent of overrun		
		Lot I	Lot II	Lot III
Raw	Fresh	57	52	52
		57	52	54
Raw	Aged 24 hours	55	60	66
		61	60	66
Raw	Aged 48 hours	75	66	73
		70	66	80
Pasteurized	Fresh	28	29	33
		27	35	33
Pasteurized	Aged 24 hours	41	51	48
		41	43	47
Pasteurized	Aged 48 hours	65	55	66
		75	45	66
Pasteurized	Aged 72 hours	75	63	66
		76	66	67
Homogenized	Fresh	40	42	41
		40	40	41
Homogenized	Aged 24 hours	50	70	82
		70	68	80
Homogenized	Aged 48 hours	64	70	91
		71	83	89
Homogenized	Aged 72 hours	66	71	91
		70	83	91

When frozen fresh, the raw cream gave an overrun of about 50 per cent; the pasteurized cream, 30 per cent; and the

homogenized cream, 40 per cent. In each case aging the cream made possible a higher swell.

EFFECT OF TIME OF FREEZING ON THE OVERRUN

In order to get the desired overrun, enough time must be given for the incorporation of air into the mixture. An 18 per cent cream, after the sugar is added, is too thin to whip until a temperature of 31 degrees Fahrenheit is reached. If the freezing is finished in a few minutes, less air will be whipped into the mixture than when from 10 to 15 minutes is taken. The mixture is frozen when it reaches a temperature of 28 or 27 degrees.

Table II gives the results of freezing, for different lengths of time, three lots of 18 per cent pasteurized cream containing the same amount of sugar. In each case the temperature of the "mix" was 40 degrees when the machine was started.

TABLE II.—EFFECT OF TIME OF FREEZING ON OVERRUN

	Time of freezing	Per cent of overrun
	Minutes	
Lot I:	11	54
	12	54
	5	38
	5.5	38
Lot II.	13	60
	12	60
	4	33
	4	34
Lot III:	11	54
	12	55
	5.5	37
	5	38

Table III illustrates the effect of speed of machine on the overrun. The temperature of the "mix" was 40 degrees Fahrenheit when the machine was started. The speed was changed by substituting different sizes of pulleys on the shaft. In each case the same freezing mixture was used and the ice cream was frozen to the same consistency.

TABLE III.—EFFECT OF SPEED OF MACHINE ON OVERRUN

Revolutions a minute	Overrun		Time of freezing	
	Lot I	Lot II	Lot I	Lot II
	Per cent	Per cent	Minutes	Minutes
50	25	33	10	11
	28	33	11	10
	25	35	9	12
150	48	43	7	7
	48	39	8	5
	50	40	7.5	6
175	45	58	7	6
	50	50	7.5	6.5
	52	55	8	6

A speed of 50 revolutions a minute proved too slow for the proper whipping of the mixture. Not only was the overrun low, but the texture was coarse and the body of the ice cream weak and slushy.

The upright dasher freezer produced ice cream of excellent quality both from the standpoint of overrun and of body and texture when operated at the rate of 150 revolutions a minute, but an increase to 175 revolutions a minute made no appreciable difference in quality or overrun.

EFFECT OF KIND OF MACHINE ON OVERRUN

The upright batch machine was compared with the continuous disk machine to determine which produced the larger swell and which obtained the swell most easily. Three lots of cream were frozen, two freezings of each lot being made in each machine. The temperature of the "mix" was the same in each case so that a possible difference in the overrun would be due to the working of the two machines.

TABLE IV.—EFFECT OF KIND OF MACHINE ON OVERRUN

Machine used	Per cent of overrun	Time of freezing	Brine
		Minutes	Degrees
Lot I:			
Continuous machine	98–99	12	12
Upright batch machine	60–60	13	14
Lot II:			
Continuous machine	61–60	8	7
Batch machine	55–60	13	16
Lot III:			
Continuous machine	70–72	10	8
Batch machine	60–60	12	12

The results given in Table IV show that a higher overrun was obtained with the continuous machine than with an upright batch machine. Rapid freezing in the continuous machine resulted in a lower overrun, as shown by the results of Lot II. The quality of the ice cream, however, was better when frozen in the batch machine, the cream being smoother and not as coarse grained as that in the continuous machine.

EFFECT OF AMOUNT OF FREEZING ON OVERRUN

In order to determine at what point in the process the ice cream has the highest amount of swell, several freezings to various degrees of hardness were made. Table V shows the overrun obtained.

TABLE V.—EFFECT OF AMOUNT OF FREEZING ON OVERRUN

Amount of freezing	Per cent of overrun		
	Lot I	Lot II	Lot III
Consistency of soft, thin gravy	30	25	20
Thick gravy	45	44	48
Frozen hard	25	24	30

The proper consistency was obtained when the mixture had a temperature of from 28 to 27 degrees and resembled a thick gravy. It then had a yield of approximately 50 per cent. When taken from the freezer before this point had been reached, the ice cream had not the desirable creamy consistency, nor the maximum swell. Over-freezing was found to produce a coarser quality and to decrease the amount of swell.

FILLERS DO NOT AFFECT OVERRUN

It has frequently been supposed that the various fillers used in ice cream made possible a higher swell. Table VI shows the results of a number of freezings made in order to compare the overrun obtained when a filler was used with ice cream frozen from the same mixture without a filler. The various fillers had no appreciable effect on the swell.

In each case, an 18 per cent pasteurized cream was used, one-half of which was mixed with filler and one-half frozen without the filler. The amounts of filler used were: Gelatine, 2 ounces for a 5 gallon batch; gum tragacanth, 1 pint stock for 5 gallon batch; ice cream powder, according to directions accompanying package; evaporated milk, 20 per cent in the formula; eggs, 2 for a gallon of mix; corn starch, 3 ounces for a 5 gallon batch; and rennet, 2 ounces for a 5 gallon batch.

TABLE VI.—EFFECT OF FILLERS ON OVERRUN

Filler	Percentage of overrun		
	Lot I	Lot II	Lot III
Gelatine	43	43	33
	54	43	33
Control (no filler)	53	43	38
	54	38	33
Gum tragacanth	45	54	54
	45	55	54
Control	48	54	53
	48	50	52
"Purity" cream powder	54	43	55
	54	80	50
Control	50	48	50
	52	82	48
Evaporated milk	40	45	43
	40	40	46
Control	43	43	44
	40	43	45
Eggs	33	43	40
	35	38	35
Control	35	43	43
	35	42	43
Cornstarch	42	60	46
	40	62	46
Control	35	58	50
	40	58	50
Rennet	43	46	48
	44	45	48
Control	47	52	43
	47	50	45

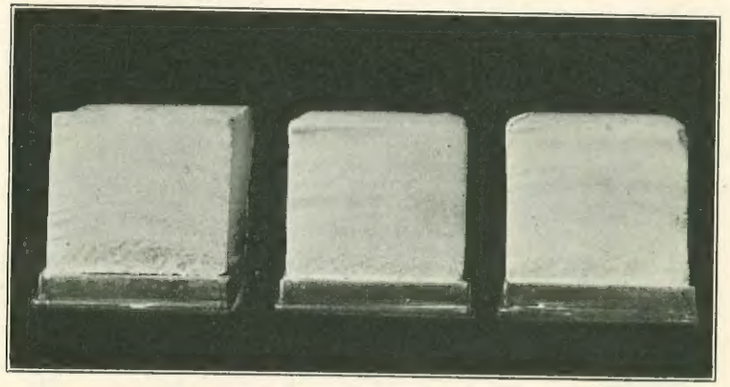
EFFECT OF OVERRUN ON TEXTURE AND QUALITY

The overrun obtained means the amount of air which is incorporated into the ice cream. The higher the overrun, the more air in the ice cream and the more open will be the texture of the product. A certain amount of swell is necessary in a high grade ice cream for without a fair overrun the product lacks the desirable texture and smoothness. Many ice cream makers, however, over emphasize the swell and as a result, the quality of their product is poor.

Figure 1 shows cross sections of three bricks of ice cream, the one at the right having 40 per cent swell; the one in

the center, 70 per cent swell; and the one at the left, 100 per cent swell. All three bricks were made from the same "mix." A glance at this figure will show which one has the most air incorporated into it, or in other words, which has the highest overrun.

The amount of overrun also determines the amount of cream that goes into a given volume of ice cream. The quart brick having the 40 per cent swell weighed 1.25 pounds. The brick with the 75 per cent swell weighed 1.57 pounds and the one with the 100 per cent swell weighed 1.1 pounds. One quart of mixture before freezing weighed 2.2 pounds.



100 per cent overrun | 70 per cent overrun | 40 per cent overrun

FIG. 1.—EFFECT OF OVERRUN ON TEXTURE

An ice cream made with a low overrun is too compact and hard, while a high swell ice cream is light and appears coarse. A good quality ice cream is represented by the 70 per cent overrun brick in the center of Figure 1.

According to the weight of ice cream, a quart having 100 per cent swell will contain only $\frac{1.10}{1.57}$ as much ice cream as that having 40 per cent swell.

Some ice cream on the market is made with even a higher swell than 100 per cent. When ice cream melts down to a small volume or appears like so much frozen foam, the overrun or swell was higher than is consistent with good quality.

Figure 2 is a graphic illustration, explaining the overrun. If the 2.5 gallons of mix shown at the left yields 3.7, 4.3, and 5.0 gallons of ice cream, the overrun was 50 per cent, 75 per cent, and 100 per cent, respectively.

EFFECT OF OVERRUN ON AMOUNT OF NUTRIENTS

Ice cream is eaten mostly for its flavor or the pleasure it affords and not much attention is given to its food value. This may be a good argument for the ice cream maker to try to obtain as high an overrun as possible, so that people can eat large quantities and not get too much nutriment.

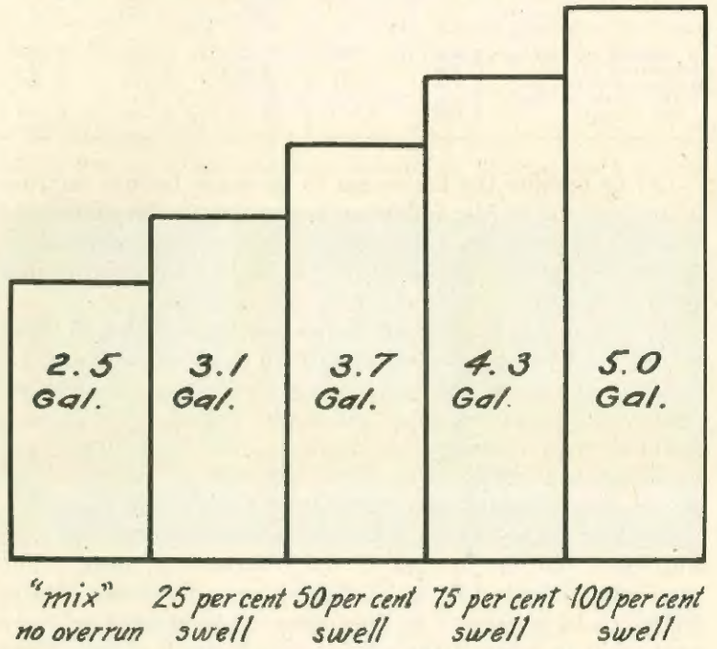


FIG. 2.—EFFECT OF OVERRUN ON VOLUME

A five gallon freezer is half full when it contains 2.5 gallons of "mix." A 25 per cent, a 50 per cent, a 75 per cent, or a 100 per cent swell will increase the volume of ice cream in the freezer, 0.6 gallons, 1.2 gallons, 1.8 gallons, and 2.5 gallons respectively.

Nevertheless, the fact remains that the amount of nutrition in ice cream is comparatively large and that it varies with the amount of air incorporated during the freezing process. Whether or not ice cream is eaten to satisfy the need for body nutrition, it is reasonable to assume that sooner or later in buying the product not only its refreshing qualities but also the nutrients it contains will be considered.

Table VII shows the weight of a quart of ice cream made with varying percentages of swell, together with amounts of fat and sugar it contained. To simplify the problem only two food elements, fat and sugar, are considered.

TABLE VII.—EFFECT OF OVERRUN ON NUTRIENT CONTENT

	Mix	Ice cream with swell of			
		25 per cent	50 per cent	75 per cent	100 per cent
Weight a quart; lbs....	2.200	1.760	1.470	1.260	1.100
Amount of fat; lbs.....	0.308	0.246	0.205	0.170	0.154
Amount of sugar; lbs.	0.330	0.264	0.220	0.188	0.165
Total nutrients, fat and sugar; lbs.....	0.638	0.510	0.425	0.358	0.319

Let us assume the ice cream to be made from a mixture of ingredients in the following proportions: 50 pounds of 16.5 per cent cream, 8 pounds sugar, 2 ounces vanilla, and 4 ounces gelatine. This mixture will test 14 per cent fat and come just within the limit set by the state law.

The ice cream made with 25 per cent swell has 1.39 times as much fat and sugar as that with 75 per cent swell and 1.6 times as much fat and sugar as in the case of the 100 per cent swell. However, an ice cream with only 25 per cent swell is not as good a commercial product as that with 50 per cent or 75 per cent swell. The ice cream with an overrun of 50 per cent contains 16 per cent more fat and sugar than that with 75 per cent swell and nearly 33 per cent more of such nutrients than in the case of the 100 per cent swell. The required per cent of fat in ice cream varies in different states from 8 to 14 per cent. In Wisconsin the legal limit is 14 per cent while in some of the neighboring states it is only 8 per cent. Good, palatable ice cream can be made with 8 per cent as well as with 14 per cent fat, but the nutritive value for a quart will be higher in the product containing the higher percentage of fat, unless other milk solids are substituted for the fat.

With the present method for testing ice cream namely, by weighing an 18 gram sample of melted ice cream in a test bottle, 2 samples of cream made from the same mixture, one with 50 per cent and the other with 100 per cent swell, will test exactly alike, while the former will have 33 per cent more fat per volume than the latter.

Commercial ice cream varies in the amount of overrun it contains all the way from 40 to 120 per cent so that the amount of cream, as well as of nutritive value, contained in a certain volume, is a varying quantity.

It is not practical to sell ice cream by weight, for the nature of the product and its manner of handling makes this quite impossible. Until some method of regulating the amount of overrun is generally adopted, purchasers of the product can, in a measure, determine its quality by weighing a certain volume and noting its openness or closeness of texture.

FACTORS INFLUENCING THE FLAVOR

As ice cream is eaten largely for its flavor, the first consideration in its manufacture should be to develop a flavor

120 per cent swell | 75 per cent swell | 100 per cent swell

FIG. 3.—EFFECT OF HIGH OVERRUN ON APPEARANCE AND TEXTURE

Too high an overrun gives a coarse grained appearance to ice cream. A product with 100 per cent or more swell is very light and fluffy.

pleasing to the trade and free from all taints and contaminations. The following are some of the factors that may influence the flavor of ice cream:

(1) quality of flavoring materials, (2) richness of cream, (3) taints of cream, (4) kind of cream, (5) fillers, and (6) storage of finished product.

GOOD FLAVORING MATERIALS ESSENTIAL

There are many cheap and inferior flavoring materials on the market which, if used in ice cream, will prodiuce an in-

ferior flavor. Only the purest and best vanilla extract should be used as this will give uniformly good results. The best grades are usually the cheapest as a smaller amount is required to produce flavor of the desired intensity. What is true of vanilla also holds true for all flavoring materials. For example, a good grade of cocoa or chocolate will make a better chocolate ice cream than will a poorer grade.

The natural fruit flavors are best for the finest ice cream, provided only good fruit is selected. Poor or spoiled fruit, nuts, or fruit flavors will always affect the quality of the finished product.

Many of the prepared fruits and fruit flavors are of inferior grade and should not be used. The imitation fruit flavors are, as a rule, made from oils and, although not in themselves harmful, should not be used in ice cream. An imitation is always inferior to the pure, natural product.

The richer the mixture, the less flavoring material is needed to produce the desired results. A "mix" low in butter fat, 8 per cent for instance, will require comparatively more flavoring materials, especially vanilla, than a "mix" testing 14 per cent fat.

ICE CREAM IS EASILY CONTAMINATED

Only the cleanest and sweetest of cream should be used in making ice cream. If the cream is old, a tainted flavor will appear in the finished product. While it is true that all the flavors in the raw product will gradually blend into the vanilla flavor, any contaminated or partly sour cream will leave its effect on the finished ice cream. Ice cream is found on the market with all kinds of tainted flavors, as of sour cream, dirty water, tin receptacles, or odors of the stable. There is no excuse for conditions of this kind. With modern equipment and facilities for holding cream sweet and pure, the product should be as clean and sweet as any confection or food on the market.

FLAVOR IS INFLUENCED BY THE KIND OF CREAM

A raw cream will produce a somewhat different flavor in ice cream than a pasteurized or homogenized cream. This difference in flavor is more noticeable if the pasteurized or homogenized cream is frozen when too fresh. The longer such cream is held or aged, at a low temperature, the less

will be the difference in the flavor of the product. A fresh, pasteurized or homogenized cream will usually produce a heated cream flavor. This flavor is not at all objectionable and some people even prefer it, but, as a rule, it is better to age the cream properly before freezing in order to get the best flavor in the finished product.

FILLERS AND THEIR EFFECT ON FLAVOR

Fillers may or may not have an effect on the flavor of ice cream. A poor grade of gelatine will have the odor of glue, and will always produce an unpleasant flavor, for the odor and flavor of the gelatine cannot be hidden by the vanilla. With a good grade of gelatine the flavor of the finished product should not be affected.

If not of inferior quality and if not used in too large amounts, gum tragacanth and numerous other gummy and vegetable powders which are used as fillers will, as a rule, have no noticeable effect on the flavor of the product. Starches, such as corn starch, rice flour, or wheat flour, when added to ice cream as a filler can always be detected in the flavor.

The kind of filler used makes little difference. If of good quality and used judiciously, it will not affect the flavor to any great extent, but no inferior materials should be tolerated in ice cream.

FLAVOR IS WEAKENED IN STORAGE

Freshly frozen ice cream usually seems to be too highly flavored. The "mix" before freezing has a much stronger flavor than has the finished product. After the ice cream has been stored for 12 hours or longer, the intense flavor disappears, and an even, uniform flavor takes its place. Usually, after storage, all the flavors blend together into the predominant vanilla flavor.

Long storage of ice cream has a tendency to weaken the flavor, so that a product in storage for several days will be less highly flavored.

THREE DIFFERENT FREEZING PROCESSES USED

The proper freezing of a mixture is no small factor in the making of ice cream. Both length of time of freezing and the temperature of the freezing mixture affect the quality of the frozen product.

The freezing is usually done by one of three methods, depending on the size of the plant and its equipment. The large factories almost invariably have a refrigeration machine in connection with the ice cream plant and use ammonia or calcium chloride brine which is pumped through the freezers. These large factories have standardized the freezing process so that little trouble is experienced in keeping a uniform temperature and pressure of the brine.

In smaller factories and creameries, the freezing mixture consists of either salt and ice or a salt and ice brine. The former is used in connection with the ordinary tub freezer and the brine where a small continuous freezer or a salt brine batch machine is installed.

Salt and ice make a very efficient freezing mixture and with proper care and attention ice cream can be very satisfactorily frozen by this method. The ice should be crushed rather fine and used in a proportion of one part of salt to 15 parts of ice. If the temperature of the "mix" is 50 degrees F. or lower, this freezing mixture will freeze a ten gallon batch of ice cream in about 15 minutes. If most of the salt is placed near the top, around the freezer, a proportion of salt and ice, 1 to 18 or 1 to 20, may be sufficient. To start the freezer on the first run of the day a little water should be added in order to help form a brine and hasten the freezing process. After the first batch is frozen, enough brine can be left in the freezer to continue with succeeding freezings.

The time of freezing for good results should be from 10 to 15 minutes. Too rapid freezing will produce a coarse, inferior ice cream, while if the time is prolonged for 20 minutes, or a half hour, the product may become too foamy and light. A little practice will enable the operator to regulate the salt and ice so that all batches will be frozen in about the same length of time. The time of freezing depends upon four factors: proportions of salt and ice, fineness of salt and ice, temperature of the mixture, and amount of sugar in the mixture.

The more salt added to the ice, the lower will be the temperature produced and the faster a batch of ice cream will freeze. If the ice is crushed rather fine, the action of the salt will be more rapid in producing a low temperature. Fine salt will also produce a low temperature more rapidly than coarse salt. However, a coarse rock salt is more economical

and is better for freezing purposes than is finer salt. The temperature of the mixture is an important item, for if the "mix" is not cooled sufficiently, it will not only take a longer time to freeze the batch, but churning may occur in the freezer and result in a somewhat buttery ice cream. For all practical purposes the "mix" should be cooled to at least 50 degrees F. before it is put into the freezer. The amount of sugar in the mixture will affect the time of freezing only to a very slight degree. Sugar passes into a true solution with cream and the more sugar in the mixture, the longer the time required for freezing. This factor is relatively unimportant as in the commercial manufacture of ice cream the amount of sugar in the "mix" from day to day is quite uniform.

Salt and ice brine may be used as a freezing mixture either in a small continuous disk freezer, or in a batch brine freezer fitted up for this purpose. The salt and ice are mixed in a wooden tank and the brine is circulated through the freezer by a rotary pump and returned to the brine tank by a return pipe. In this way the brine can be used over and over again many times. This method of freezing requires a comparatively large amount of salt. No definite rule can be given as to the proportion of salt and ice to use in making the brine. The temperature of the brine is the best indication of the quality of the freezing mixture. The brine should have a temperature of from eight to ten degrees before the freezer is started, and ought not to go above 15 degrees during the freezing. This requires careful attention in order to keep the process uniform.

TEMPERATURE OF FREEZING THE ICE CREAM

The mixture in the freezer begins to freeze and swell at a temperature of 31 degrees F. Before this temperature is reached practically no whipping of the cream will occur, as the comparatively thin "mix" is not in condition to hold the air. As the mixture passes through temperatures from 31 to 28 degrees, the swell or overrun is obtained and the ice cream is whipped into a smooth consistency. The process is usually completed when the mixture has a temperature of from 27.5 to 28 degrees. The time employed in reducing the temperature from 31 to 28 degrees should, for the best results, be about eight minutes. If this process is carried on

too rapidly, the ice cream will not have the desirable smooth consistency, and a low overrun will result.

If the process of freezing were carried on in an ideal manner, it would be necessary to have two speeds to the machine. Until the mixture has reached a temperature of about 32 degrees, the whipping point, it is practically useless to use a high speed. After this temperature is reached, however, a rapid movement of the revolving parts of the freezer is necessary to whip the mixture properly. It is usually inconvenient to arrange the machinery for two speeds and, if proper methods are employed, it is not necessary.

It is comparatively easy to cool the mixture sufficiently so that churning in the freezer will not occur. A speed of from 100 to 150 revolutions of the ordinary tub freezer and 250 revolutions of the disk or stationary freezer will produce good results.

The effect of too low speed is usually a coarse product and a low overrun. The ice cream has not the smooth texture nor the good, firm body which is desirable in a first class product. Too high a speed likewise may result in a low overrun and will cause unnecessary wear on the machine.

TRANSFERRING FROM FREEZER TO PACKER

All transferring of ice cream from the freezer to the packers should be done while the ice cream is soft. The packing cans can be filled directly from the freezer and then quickly placed in the hardening room or the hardening tank. Where only a few batches are frozen and the ice cream is hardened directly in the tub, the cans may be packed with salt and ice before being filled from the freezer.

The filled cans of ice cream must not be allowed to remain in a warm room for any length of time, as the frozen cream in the bottom and sides of the can will melt and this will, on hardening, form a crust of ice crystals.

If the ice cream is frozen to the right consistency, it can be transferred from the freezer to the cans without any loss of volume. In order to facilitate the transfer, cans of all sizes should be on hand to be filled directly from the freezer. In filling small orders, of a gallon or less, from a large can which is already hardened, a loss in volume of from 10 to 20 per cent occurs as well as a loss of time due to the difficulty of transferring the hardened ice cream to a small can.

SHOULD BE WELL HARDENED BEFORE PACKING

Ice cream is usually hardened by one of three methods: In the first, which is used in small factories where the output and equipment is limited, the ice cream is hardened in the regular packing or shipping tub. This method may be satisfactory in a small business, although the tubs require constant attention. A proportion of salt and ice, one to seven is usually employed. Eight hours after the first packing the brine must be drawn and the tub repacked with fresh ice and salt. Subsequently the tub must be repacked at least every 12 hours to keep the ice cream in good condition.

A second method of hardening, which is used in many small factories, is to place the cans filled from the freezer in a hardening tank. This tank is usually made of wood and can be drained when necessary. The cans are packed with salt and ice until ready to ship when they are repacked in the shipping tub. This method saves a great deal of time and work and is more efficient than the first method.

The third method, the one used almost universally in large factories, is to harden the ice cream in a dry hardening room. This room is well insulated and kept cold by means of brine pipes which are usually run underneath the shelves where the cans are placed. Direct expansion of ammonia is used for refrigeration. The pump is usually in operation for about 12 hours a day and the temperature is brought down very close to, or even below zero.

Ice cream should be well hardened through to the center before it is packed for shipment. This will probably take from 12 to 24 hours, depending on the method employed for hardening. In packing a well hardened can of ice cream for shipment a proportion of ice and salt, about one to eight will give good results. The ice and salt should be closely packed around the can and the top of the tub covered with a piece of burlap or by a canvas which is especially made for this purpose.

REHARDENED ICE CREAM ALWAYS INFERIOR

Rehardening means to again harden ice cream that has become soft either through careless attention in the factory, or by being shipped too great a distance.

The proper way to handle ice cream is to keep it hard at all times until consumed. A rehardened ice cream is always inferior. As soon as the cream is allowed to become soft, the watery portion, together with the sugar, settles to the bottom and the fat in the cream has a tendency to rise toward the top. A rehardened ice cream is usually coarse and full of ice crystals; the top of the can is too rich in fat, while the bottom is oversweet and not as rich.

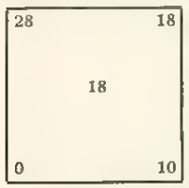
STANDARDIZATION OF CREAM FOR ICE CREAM MAKING

The commercial manufacture of ice cream has been standardized in the large factories so that the product is quite uniform in all respects throughout the year. With the present fat standard of 14 per cent, it is necessary for the manufacturer to know the per cent of fat in the cream used and to modify the cream so that the product complies with the law. By standardizing the cream every day to the correct degree of richness a uniform fat content is secured which puts a stamp of quality on the ice cream. A simple way to standardize cream may be illustrated by an example:

An ice cream maker has 400 pounds of 30 per cent cream which he wishes to reduce to a 20 per cent cream by adding skim milk. A simple solution would be:

400 x .30=120 pounds fat.
120 ÷ .20=600 pounds 20 per cent cream
600—400=200 pounds skim milk to add to the 400 pounds of 30 per cent cream.

All possible combinations can be worked out easily by the square method. The per cent of cream wanted is placed in the center of the square, the per cent cream on hand on the upper left hand corner and the per cent fat in the milk or skim milk in the lower left hand corner. Then by subtracting diagonally across the square, the proportion of cream and milk to use is easily found. A simple problem will illustrate:



Given 360 pounds of 28 per cent cream to reduce to 18 per cent cream by adding skim milk. The 18 is placed in the center of the square; the 28 at the upper left hand corner, and the o (skim milk) at the lower left hand corner. Subtracting diagonally across we get 18 and 10. The 18 represents the amount of 28 per cent cream and the 10 the amount of skim milk to use. There are 360 pounds of 28 per cent cream to reduce. Then $\frac{360 \times 10}{18}$ or 200 pounds represents the amount of skim milk to add to the 300 pounds of 28 per cent cream. 360 + 200 = 560 pounds of 18 per cent cream. Another illustration of a problem a little different is illustrated by:

An ice cream maker wants to prepare 500 pounds of 18 per cent cream. He has 36 per cent cream and 4 per cent milk. Arranging the figures in the square as above we have 14 pounds of 36 per cent cream to be used with every 18 pounds of 4 per cent milk, which together make 32 pounds of 18 per cent cream.

Then $\frac{500 \times 14}{32}$ =218.7 pounds cream.

and $\frac{500 \times 18}{32}$ =281.2 pounds milk.

281.2 plus 218.7=499.9 pounds of 18 per cent cream.

A UNIFORM SWELL CAN BE MAINTAINED

Every ice cream maker wants as high a yield as possible, consistent with a good quality of ice cream. The overrun obtained from day to day should be as nearly uniform as practicable so that the product will be of nearly the same quality throughout the season.

The overrun in ice cream is always based on the volume of the mixture before freezing. For example, if 15 gallons of "mix" when frozen yield 25 gallons of ice cream, the overrun is 10 gallons, or 66 per cent. The common way of determining the yield is to determine the number of gallons of cream used in making up the "mix" and to count the number of gallons of frozen ice cream. However, in this way the increase in volume due to the addition of sugar, filler, and flavor is disregarded. The overrun obtained in this way is always a little higher than the actual overrun. To illustrate: If 2 ten gallon cans of standardized cream when made into ice cream yield 40 gallons, the overrun would be 20 gallons or 100 per cent. The sugar, flavor, and filler added to the 20 gallons of cream will, however, increase the volume of the "mix" to 22 gallons. Then if this 22 gallons of "mix" makes 40 gallons of ice cream, the increase or overrun would be only 18 gallons or 82 per cent.

The only accurate way to determine the overrun is to weigh a certain volume of "mix" and then weigh the same volume of ice cream. The ice cream will weigh considerably less depending on the amount of overrun. To illustrate:

1 gallon of "mix" weighs 8.8 pounds. The same volume of ice cream weighs 5.2 pounds. The difference in weight is 3.6 pounds. This loss of weight divided by the weight of the ice cream will give the per cent overrun.

Thus: $\frac{3.6}{5.2}$=69.2 per cent or expressed in simple proportion,

5.2 : 3.6 : : 100 : x

x=69.2 per cent overrun.

Or 8.8 : 5.2 : : x : 100.

x = 1.692 or one gallon of mix weighing 8.8 pounds will yield 1.692 gallons of ice cream. The overrun then is 0.692 or 69.2 per cent.

By knowing the weight of a certain volume of mix and then weighing the same volume of ice cream from time to time, an ice cream maker may know exactly how much overrun the machine delivers from day to day without counting the number of cans of ice cream frozen.

NEVER FREEZE SOUR CREAM

Nothing but the sweetest and cleanest cream should be used for ice cream. Partially sour cream should under no circumstances be mixed with the sweet cream. Inquiries have been received at the Experiment Station from ice cream makers wanting to know what to add to slightly sour cream to make it good enough for use. If raw cream cannot be kept sweet at the factory, the best thing to do is to pasteurize the cream and then hold it until ready for use. It is a good policy to pasteurize all cream for ice cream making, for in this way not only is the keeping quality improved, but all danger resulting from the probable presence of disease-producing organisms in the cream is eliminated and a product with a low bacterial content is possible.

WHEY CREAM CAN BE USED

Since cheese factories have begun the separation of whey cream, inquiries have been received as to whether or not this cream could be utilized for the making of ice cream. There is no reason why whey cream cannot be used, provided it is kept sweet and clean.

It is advisable, however, to mix the whey cream with some pasteurized cream in making up the "mix," as the high testing whey cream, if reduced to the comparatively low per cent of fat used for ice cream making, is not viscous enough to produce good body and texture in the finished product.

THREE METHODS OF TESTING ICE CREAM

An ice cream maker should test his ice cream occasionally to see if his method of standardizing the mixture is correct. On acount of the large amount of sugar in ice cream the ordinary method for testing cream cannot be used. Either one of the following three methods, if carefully carried out, will give sasfactory results.

THE SULPHURIC ACID TEST

In making the sulphuric acid test, a 9-gram sample of the melted ice cream, well mixed, is weighed into an 18-gram test bottle. This is diluted with about the same amount of luke warm water. The acid is then added, a little at a time, at intervals of about a minute or two, until a chocolate brown color appears in the test bottle. The acid must be well mixed with the sample each time it is added. No definite rule can be given as to the total amount of acid to be added as this will vary with different ice creams. As soon as the correct color appears in the test bottle, a little cold water is added, to check the action of the acid. The bottle is then immediately whirled as in making a cream test, except that two whirlings and one filling of hot water is sufficient.

THE GLACIAL ACETIC AND HYDROCHLORIC ACID TEST

In making the glacial acetic and hydrochloric acid test, a 9-gram sample is again weighed into an 18 gram bottle. A mixture is prepared using equal parts of glacial acetic acid and concentrated hydrochloric acid. Twenty cubic centimeters of this acid mixture is added to the 9-gram sample in the test bottle and all is well shaken. The bottle is then placed in a hot water bath, and shaken at intervals, until a brown color appears, when it is whirled in the Babcock tester in the usual way.

THE SULPHURIC AND NITRIC ACID TEST

In making the sulphuric and nitric acids test, an 18-gram sample of the ice cream is placed in a clean, dry, and weighed beaker. A mixture of sulphuric acid and nitric acid is prepared in the proportion of 12 cubic centimeters concentrated nitric acid to 88 cubic centimeters of sulphuric acid (specific gravity 1.82-1.83). About 8 cubic centimeters of this acid mixture is then added to the sample in the beaker, mixing it with a rotary motion of the beaker. If the action of the acid is sufficient to cause the mixture to foam up and fume, and if after fuming stops, the color of the mixture is dark brown, no more acid is necessary. If the above action is not complete, more of the acid mixture shoul be added until no more fuming occurs. The contents of the beaker is then poured into an 18-gram bottle. The beaker is carefully rinsed with a little hot water to remove all fat and the contents added to the test bottle. The test is then completed in the usual way.

ICE CREAM IS HARD TO SAMPLE

A melted sample of ice cream is very foamy and in order to get a correct sample for testing, the ice cream must be well mixed by pouring from one vessel to another 10 or 15 times. If allowed to stand for only an instant, the foam will again quickly rise to the top. In weighing ice cream into the test bottle no pipette should be used but the well-mixed sample should be poured rapidly from the beaker into the test bottle. Then by keeping the sample mixed in the bottle and pouring out until the correct weight is obtained, a fair sample can be secured for testing.

FAT TESTS FROM PACKERS SHOULD NOT VARY

It is claimed by some that it is difficult to obtain a fair sample of ice cream from a packing can, because the fat content from various portions of the container will vary. No appreciable difference in the fat content of ice cream taken from different portions of the packing can, if the cream was kept hard and in the proper condition, is noticeable. Fat tests made from the top and bottom of packers seven or eight days old showed no difference in the fat content. Variations found in the fat content from a well hardened

container have been due, without doubt, to errors in sampling or from weighing an incorrect sample into the test bottle.

If, however, the ice cream in a packer, has been allowed to become soft for a time, due to lack of proper attention during hardening and shipping, a decided difference will be found in the fat content of ice cream from the top and from that at bottom of a container.

The results of a number of tests of ice cream from the top and bottom of a container made under various conditions are given in Table VII.

TABLE VII.—FAT TESTS FROM TOP AND BOTTOM OF PACKING CAN

Age of ice cream	Cream		Fat in ice cream	
	Kind	Fat	Top	Bottom
Days ice cream kept hard		Per cent	Per cent	Per cent
2	Pasteurized	18	14.5	13.0
3	Pasteurized	18	14.5	14.0
4	Raw	25	23.5	21.0
6	Pasteurized	18	15.5	14.0
7	Pasteurized	18	14.5	13.5
8	Pasteurized	20	17.5	15.5
Ice cream soft one day, then rehardened				
2	Pasteurized	18	20.0	11.0
2	Pasteurized	16	19.5	9.5
3	Pasteurized	18	22.0	8.0
3	Pasteurized	15	16.5	9.0
4	Homogenized	18	14.5	14.5

THREE TYPES OF FREEZERS ARE USED

Three types of freezers are at present in use in the commercial manufacture of ice cream. The vertical batch machine is the most common one. All the ordinary salt and ice tub freezers are of this type. The vertical batch brine machine is also very popular. Some of the users of the vertical machines claim that this type produces ice cream of the best quality, especially in respect to smoothness and texture.

The horizontal batch brine type of machine is often preferred. This type of machine is constructed similarly to the vertical machine except that the freezer and dasher are in a horizontal position. Excellent results are obtained from its use and little trouble is experienced in getting the swell.

The continuous disk freezer has gained in favor in recent years, because with it the process of freezing can be carried on continuously. The freezing is accomplished by pumping the freezing mixture through revolving disks. The machines are made either for using salt and ice brine or to connect with

the refrigerating system of the factory. Many of these machines are being used today and very satisfactory results are being obtained.

ICE CREAM MAKING PROFITABLE FOR CREAMERIES OR DAIRIES

Many creameries throughout the state have begun the manufacture of ice cream and have continued it with success. The chief factor that should determine whether or not a creamery is to add an ice cream department is its location. Not one creamery in twenty is so located as to be able to enter the business on a profitable basis. If located in a city of fair size or near a city with good shipping facilities to smaller towns near by, and the prospect of trade is not hampered by too strong competition, no creamery need hesitate to install equipment for making ice cream. The profits derived from this source can be double those from butter making. With an average output of from 25 to 50 gallons a day during the season, the ice cream department can be made a profitable side line to the manufacture of butter.

In the smaller cities, ice cream making can also be made a profitable side line of a small milk plant or pasteurizing plant. The largest flow of milk usually occurs during the summer months and milk plants contracting for the product from farms often have a surplus at this season which can be manufactured into butter or ice cream. A milk plant usually has pasteurizing facilities and refrigerating machinery which enables it to handle the cream properly for ice cream making.

EQUIPMENT FOR A CREAMERY OR SMALL ICE CREAM PLANT

The equipment necessary for manufacturing ice cream in a creamery where the power is already available will be about as follows:

1 10 gallon upright freezer	$100.00
1 ice crusher	50.00
Packers and cans	200.00
Shafting and pulleys	15.00
1 hardening tank	20.00
1 mixing vat	10.00
1 extra wash sink	15.00
Small tools and conveniences	25.00
Total	$435.00

An ordinary ten gallon tub freezer will be sufficient at the start. This freezer will cost from $75.00 to $100.00 and can be replaced by a better machine as the business increases. The number of packers and cans to be bought will depend somewhat on the prospect for customers. About 3 or 4 packers and cans for each customer should be sufficient for handling the trade at the outset. The prompt return of empties will reduce the number necessary.

HOMOGENIZER IMPROVES ICE CREAM

Nearly all large ice cream factories make use of a homogenizer. Cream which has been passed through the homogenizer makes a smoother and better bodied ice cream than cream which has not been homogenized. It is also possible to manufacture a good sweet cream from sweet butter and skim milk when the cream supply is short. An ice cream made from such manufactured cream is as good in all respects as when made from the natural cream, provided, of course, that the butter from which it was made is sweet and wholesome.

Bad or rancid butter cannot be used in making a cream for ice cream purposes, for it will invariably produce a bad flavored ice cream. The possibility of utilizing cheap material in manufacturing cream by means of the homogenizer is very limited if not entirely prohibitive.

The homogenizer has a legitimate place in an ice cream factory and, if rightly used, has an economical value.

The body and texture of ice cream is improved by homogenizing the cream before using, so that large amounts of filler are not necessary. All churning of the cream in the freezer is eliminated and there is no possibility of any fat rising to the top in the packing can.

SANITARY SURROUNDINGS ARE NEEDED

The sanitary conditions under which some ice cream is made are far from ideal. Except in large factories most ice cream is still made in cellars. In a certain small city where 13 establishments are making ice cream, all but three have the equipment in the dark, poorly ventilated and far from clean cellar or basement of the building. The cans are very poorly washed and rarely steamed. The ice cream makers and attendants are untidy in personal appearance and very careless in handling the cream.

The cellar is not the place for manufacturing ice cream. This product ought to have the best lighted and most sanitary location in the building. All utensils should be scrupulously clean and the ice cream maker and attendants should be men of the cleanest personal appearance and habits.

The usual high bacterial counts made on ice cream show clearly that the product is handled, in many instances, in a careless manner and without an appreciation of the value of sanitation. There is no reason why ice cream any more than market milk or market cream should have a bacterial content of from 20 to 100 million to the cubic centimeter.

A FEW SIMPLE FORMULAS

In the commercial manufacture of ice cream no definite formulas are followed. Although many combinations have been tested with good results, no attempt had been made at the Wisconsin Experiment Station to work out any ideal formula for ice cream. The formulas given are for 10 gallons of finished ice cream.

I. 5½ gallons 18 per cent cream (pasteurized).
8 pounds sugar.
2 ounces gelatine.
4 ounces vanilla extract.

II. 4½ gallons 18 per cent cream (pasteurized).
1 gallon condensed milk.
8 pounds sugar.
2 ounces ice cream powder.
4 ounces vanilla extract.

III. 5½ gallons homogenized 16.5 per cent cream.
8 pounds sugar.
2 ounces gelatine.
4 ounces vanilla extract.

IV. 40 pounds 22 per cent cream (homogenized).
4 pounds condensed milk.
8 pounds sugar.
4 ounces vanilla extract.

V. 44 pounds 20 per cent cream.
8 pounds sugar.
2 ounces cream powder or
½ ounce gum tragacanth.
4 ounces vanilla extract.

Formula IV, which contains no filler, will make an excellent quality of ice cream which, provided it is well packed, will remain in good condition for a week.

All the above formulas may be modified to reduce or increase the fat content of the ice cream. The lower the fat content of the cream, the more filler must be added to produce a smooth ice cream.

The sugar, filler, and flavor added to the cream will increase its volume about 10 per cent and will usually reduce the fat content 2½ per cent. An 18 per cent cream used as a basis in making up a "mix" will produce an ice cream testing 15½ per cent.

All the various fruit ice creams, such as strawberry, raspberry and orange, are easily made by stirring the clean, ripe, crushed fruits, either fresh or preserved, into the vanilla ice cream at the time it leaves the freezer and when still in a soft condition.

An ice cream maker can make any number of different ice creams all from the original vanilla mixture by using colors and crushed fruit flavors or a combination of crushed fruits and nuts.

SUGGESTED SCORE CARDS FOR JUDGING ICE CREAM

THE WISCONSIN SCORE CARD

Flavor	40
Body and texture	20
Bacteria	20
Fat	10
Appearance and color	5
Package	5
Total	100

This score card has been worked out at the Wisconsin Station where ice cream is considered a food product similar to milk and cream and as such, the bacterial content is taken into account.

The following score cards have been proposed for the judging of ice cream.

[3]

Flavor	45
Texture	25
Richness	25
Appearance	10
Color	5
Total	100

[4]

Flavor	45
Body	20
Texture	20
Permanency	10
Package	5
Total	100

Both of the suggested score cards place great emphasis on the flavor of the product and this is the primary consideration in judging ice cream. Neither of the score cards, however, place any emphasis on the sanitary quality of the product. A product may taste ever so good and still be very unwholesome. The only way to determine the sanitary condition of an ice cream seems to be a bacterial analysis. The bacterial count in ice cream, although as yet quite unsatisfactory, due to wide variations found in commercial ice cream, is nevertheless, an indication of the purity and sanitary quality of the materials used in making the ice cream and a criterion of the cleanliness of the operations in the factory.

[3] Bulletin 123, Iowa Station.
[4] Bulletin 155, Vermont Station.

DISCUSSION OF THE WISCONSIN SCORE CARD

Careful consideration should be given that the flavor shows no indication of anything but the sweetest and best cream combined with the characteristics of the flavoring materials used.

BODY AND TEXTURE INDICATE QUALITY

The ice cream should be firmly frozen and smooth. Any indication of coarseness or the presence of icy crystals should be scored. The body should be firm, yet not sticky. Too much filler will usually make the ice cream sticky and will prevent it from melting easily in the mouth.

THE BACTERIAL CONTENT SHOULD BE LOW

The bacterial content of a perfect ice cream ought not to be more than 20,000 to the cubic centimeter. One point should be deducted for every increase of 10,000 bacteria to the cubic centimeter until 100,000 is reached when two points should be deducted for every increase of 50,000 to the cubic centimeter.

FATS AND SOLIDS ARE IMPORTANT

The fat content of ice cream, being determined by law in most states, should receive consideration. Ten per cent of the total score is allowed for a perfect fat content as determined by the local legal limit. When falling below this limit, the score should be zero.

GOOD APPEARANCE MEANS NEATNESS

The color of ice cream should be characteristic of the fruit or flavor used. A plain vanilla ice cream should have the natural color of a pure cream. The general appearance of the ice cream should be clean.

A CLEAN PACKAGE IS ESSENTIAL

The container should be clean, free from rust, and present a neat appearance. Brick ice cream should be neatly wrapped and the wrapper should be clean. The layers of ice cream in the brick should be uniform.